ON THE PATHOLOGY AND CLASSIFICATION OF INTUSSUSCEPTIONS, WITH A RÉSUMÉ OF THOSE ARISING FROM THE APPENDIX CÆCI.

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INTUSSUSCEPTIONS may be classified, firstly, into single, double, triple, etc. As almost every intussusception is regarded as single, the above divisions are frequently disregarded. But as it is my desire to draw attention to the great frequency of the occurrence of double intussusceptions, I wish to emphasize this method of classification. Of single intussusceptions, four kinds are said to be recognized, namely, enteric, *i.e.*, of small bowel only; ileocolic when small bowel is prolapsed through the ileocæcal valve; ileocæcal when the ileocæcal valve forms the leading part of the intussusceptum; colic when only large bowel is implicated. By ileocolic is meant that the invagination has begun in the ileum and then passed wholly or in part through the ileocæcal valve. This passage through the valve in no way constitutes a second intussusception any more than does the passage of an intussusceptum through another segment of the bowel. Therefore the word ileocolic should be strictly confined to this, and be merely understood to mean a subvariety of enteric intussusception; and a variety which must soon cease by the inability of more gut to become prolapsed through the valve, when a second and colic intussusception may become added.

That considerable difference of opinion exists as to the relative frequency of these different forms of intussusception is quite clear from the following statistics, derived from the general literature, St. Thomas's and St. Bartholomew's Hospitals.

VARIETY.

Author.	Enteric.	Ileocolic.	Ileocæcal.	Colic.	The Rest.
Treves*....	30 per cent.	8 per cent.	44 per cent.	9 per cent.	9 per cent.
Sargent†...	11 per cent.	5 per cent.	69 per cent.	5 per cent.	10 per cent.
Eccles‡....	4 per cent.	2 per cent.	87 per cent.	5 per cent.	2 per cent.

It is noticeable that the chief variations in numbers exist among the enteric and ileocæcal varieties, and of itself suggests that there are some difficulties in the diagnosis and differentiation of these forms. The three sets of statistics agree in that the ileocæcal form is the most common, the ileocolic the most uncommon, and that over 90 per cent. of cases are examples of single intussusceptions. Such a state of affairs may be taken as representing the sum total of the present-day views.

Observations and Cases.—During 1901 and 1902 I operated on fourteen cases of intussusception, and from observations made on these cases it was borne in upon me that either I had struck on a most remarkable series or that there had been errors in the previous observations.

My first case found was the only one that I had diagnosed as ileocæcal, and, as subsequent observations made me examine my notes again carefully, I was compelled to put to myself the question as to why I had diagnosed the variety as ileocæcal at all; and found myself compelled to take up the following rather weak position. My reasons were, firstly, because on superficial examination the intussusception obviously started at the ileocæcal region; secondly, I had found something that felt like the valve per rectum; and, finally, and I am sorry to say not least, I had been taught that it was almost always safe to diagnose it on such grounds. In fact, there was no positive evidence at all that it was really ileocæcal. But in my notes I find that I observed also that the last half-inch or so of the ileum was very dark in color, and had to be reduced by traction on the small bowel. Hence I now believe my original diagnosis to have been erroneous, and that I was really dealing with a small

* Intestinal Obstruction.

† St. Thomas's Hospital Reports, 1900.

‡ St. Bartholomew's Hospital Reports, three papers.

enteric intussusception that had become impacted in the ileo-cæcal valve, and so had led to a second intussusception in which the cæcum passed into the colon. Thus, primarily, it was of the ileocolic subvariety of enteric, and subsequently became double by means of the addition of a colic intussusception to it, ileo-colic-colic. In three previous communications * I have not classed this case as a double intussusception, but on further consideration I have decided to do so now. Of my small series of fourteen cases no less than eleven were double. This gives a percentage of 80 approximately. The remaining three, or 20 per cent., were single and colic. This is a very remarkable state of affairs; and I have considered and reconsidered the matter, but feel so sure of my observations that it has been thought worth while to try and turn the attention of other observers to the point. I am fully conscious that, as Carlyle says, "Curious to think how, for every man, any the truest fact is modelled by the nature of the man. I said, The earnest man, speaking to his brother men, must always have stated what seemed to him a fact, a real appearance of Nature. But the way in which such an appearance or fact shaped itself, what sort of fact it became for him, was and is modified by his own laws of thinking; deep, subtle, but universal, ever operating laws. The World of Nature, for every man, is the Phantasy of Himself; this world is the multiplex Image of his own Dream." Therefore I abstain from making suggestions further than I have done, and give no results from my figures. But it will be stated later which form or forms of double intussusception are considered likely to be found the more common. The errors that seem to have arisen in connection with these cases may be traced mostly to the fact that the last one-half to one inch of the ileum has not been examined.

The ileocæcal variety is the one most frequently diagnosed wrongly. In fact, when examined, its diagnosis rests more on preconceived notions and absence of evidence that the case was really otherwise than upon any real positive fact that indicated

* St. Thomas's Hospital Reports, 1901, and Journal of Comparative Pathology, 1903-4. (Two papers.)

its true nature. "Ileocæcal" has been diagnosed over and over again in cases reduced by manipulation, inflation, injection of water, etc.; where there has been no post-mortem examination; times without number where a hastily reduced gut has been even more hastily replaced in the abdomen, when neither the reduction nor the reduced gut has been observed, and so forth. Such is the state of affairs, that any case diagnosed as ileocæcal requires more steadfast proof than one diagnosed as enteric or colic, because one feels that the latter is based on actual observation, and that the former is not.

Three cases of the series have been put down as single intussusceptions, and all three of the colic variety. But further consideration has led me to believe that one of these that began in the outer pouch of the cæcum was double, and that it arose in this way. The inversion of the outer pouch of the cæcum was followed by that of the caput coli, which then blocked the ileocæcal valve, and so caused a secondary invagination of the ileocæcal variety to be superimposed. The double intussusception would be called colic-ileocæcal. Unfortunately, I did not know of or recognize the possibility of this variety at the time when the operation was performed.* If this case were accepted as a double intussusception, the percentage would rise from 80 to 87!

All of the cæcum which lies below the level of the ileocæcal valve, *i.e.*, the caput coli and the appendix, if invaginated, are very prone to be complicated by the addition of a second invagination of the ileocæcal variety, colic-ileocæcal. This form of invagination is doubtless much more common than is thought, but is not so frequent as that in which trouble begins in the lower part of the ileum.†

The three examples of single intussusception that passed under my notice were of the colic variety,—one started in the cæcum, one in the ascending colon along with a sarcoma, and one in the transverse colon.

* Nor in the paper in the St. Thomas's Hospital Reports, 1901.

† The above is the case if the ascending colon lies passive. But if it is active by its peristalsis, it may add a colic intussusception. The double might be colic-colic. Or it might be triple colic-colic-ileocæcal.

SUGGESTED TABLE OF THE VARIETIES OF INTUSSUSCEPTION.

Variety.	Probable Frequency.	Definition.
Single.		
1. Enteric.	Uncommon.	Small gut into small gut.
2. Ileocolic.	Rare by itself.	Enteric through valve.
3. Ileocæcal.	Uncommon.	Originates at the valve.
4. Colic.	Probably the most common single intussusception.	Large gut into large gut.
Double.		
1. Double enteric.	Rare.	Enteric into small gut.
2. Ileocolic-colic.	Most common of all intussusceptions.	Ileocolic "impacted" in valve, the cæcum invaginated into colon.
3. Enteric-ileocolic.	Very rare.	Double enteric, with one part prolapsed through valve.
4. Enteric-ileocæcal.	Second most frequent variety.	Enteric pushing valve in front of it.
5. Ileocæcal-colic.	Very rare.	Ileocæcal and cæcum into colon.
6. Double colic.	Rare.	Colic into large gut.
7. Colic-ileocæcal.	Fairly common.	Caput coli of cæcum invaginated first, and blocks the valve, causing ileocæcal intussusception.

Note the distinction between an ileocæcal-colic and a colic-ileocæcal intussusception, the primary invagination is put first.

The above table indicates that it seems likely that double intussusceptions may prove to be more common than single; that the ileocolic-colic form is the most common; the colic-ileocæcal or the enteric-ileocæcal next in frequency, and that true ileocæcal forms by themselves are rare. In making up the names, I have adopted the simple expedient of building up the compound names in such a way that they contain and explain the total structure of the double intussusception. Hence, as soon as one becomes familiar with the names, all become simple.

The time is scarcely ripe to consider triple or more complicated intussusceptions. But the double variety, doubtless very rare, enteric-ileocolic, *i.e.*, a subvariety of double enteric, is the

one most likely to form a triple intussusception, enteric-ileocolic-colic. Or the double enteric may take on an ileocæcal form, *i.e.*, enteric-enteric-ileocæcal.*

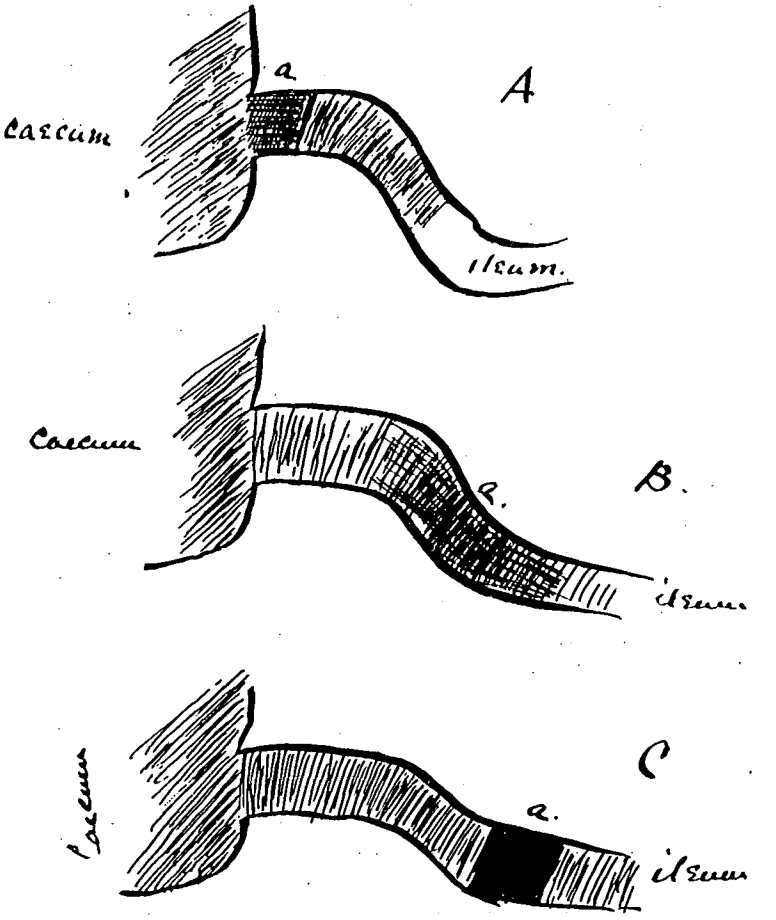
The Diagnosis.—On looking down the list of double intussusceptions, it will be seen that the greatest difficulty in diagnosis will be between the ileocolic-colic and the enteric-ileocæcal forms.

The Reduction.—When once the reduction of an invagination is started, it proceeds easily enough, and if opportunity occurs, it can be seen that much gut is reduced before any small bowel is expressed from the cæcum. This suggests that in reality only a little small bowel may have been engaged, and that the reduction so far has merely been that of the colic part of a double intussusception. If the form was merely ileocæcal, this simple reduction might continue to the end; but it is almost a platitude that the final part of the reduction of an intussusception gives most trouble. If an intussusception is first reduced in part by inflation per rectum, it is this small enteric intussusception that has been left unreduced. This combined method of treatment by inflation and operation has been much practised at the Hospital for Sick Children, Great Ormond Street, London, and has some advantages over an immediate unaided laparotomy. The inflation reduces the colic part, and leaves the enteric to be reduced by operation, which procedure must never be omitted.

About this time the small intestine will begin to be expressed from the cæcum; the final reduction may take place suddenly, and a small enteric intussusception be expelled from the cæcum as though shot out from an ileocæcal fossa. Or traction on the small bowel may be necessary, and if combined with expression and used carefully, it will be frequently noticed that the last half-inch of the ileum is withdrawn from the ileocæcal valve. Or after reduction, a lateral dimple is noticeable

* The rare chronic intussusception associated with Meckel's diverticulum is probably the most common triple or quadruple invagination in practice.

FIG. 1.



A. Invagination began in the ileum close to the cæcum, and the small enteric intussusception is easily overlooked. In *B* and *C* the invagination began farther from the cæcum, and in each there would be a definite enteric intussusception. In *C*, the apex of the primary intussusception was strangulated in the jaws of the ileocæcal valve, and the shaded part, *a*, is not strictly definite. In *B* the valve was pushed in front of the intussusceptum, and *a*, the point of origin of the involution, has gradations of discoloration on either side. *Varieties.*—*A* was ileocolic-colic; *B*, enteric-ileocæcal; *C*, ileocolic-colic. *A* is the most common form.

in the last half-inch or so of the ileum. The last appearance certainly suggests that the invagination started in this lateral dimple and led to the engagement of the terminal portion of the ileum in the ileocæcal valve.

After Reduction.—The most important part to examine is the termination of the small bowel. It may be noticed that the last half-inch is frequently observed to be sharply defined from the contiguous bowel by its deeper or even black color; also by being frequently not œdematous and without adhesions. The obvious inference is that this part has been strangulated in the ileocæcal valve, and this may have been rendered certain by previous observations made during the reduction. In other cases, which do not seem to be so common and in which a small enteric intussusception can always be seen when the reduction is done carefully, a gradation of color is noticed reaching a maximum at a variable distance up the small gut above the cæcum, and at the place where the invagination arose. It is by no means easy to decide whether the apex of the intussusceptum of this enteric invagination has gone through the valve or not. If the gradation of discoloration is similar on both sides of the place where the infolding originated, and there are no sharp lines of demarcation on either side, it may be inferred that the intussusceptum pushed the ileocæcal valve in front of it. On the other hand, if the discoloration of the primarily invaginated spot is sharply defined, it probably passed through the valve. Careful observation during the time of reduction may help one to form an opinion. Again, the higher that the enteric intussusception arises above the valve the more likely is its intussusceptum to have become œdematous, and so be unable to pass through. Consequently, the valve will be pushed on in front of the original intussusception, and the second invagination will be of the ileocæcal variety.

It is doubtful if the time or the condition of the appearance, during reduction, of the appendix helps much, though the venous return from that organ would appear to be most interfered with when the ileum just above the ileocæcal valve is engaged in it.

TABLE OF THE DIFFERENCES BETWEEN THE ILEOCOLIC-COLIC AND THE ENTERIC-ILEOCÆCAL INTUSSUSCEPTIONS.

Ileocolic-colic.	Enteric-ileocæcal.
1. Last part difficult to reduce if at all large, and very likely reduced suddenly.	Easy to reduce, and reduction may be smooth.
2. Traction very likely necessary.	Traction usually unnecessary.
3. Probably no enteric intussusception seen.	Enteric intussusception probably seen.
4. Bowel most discolored near the cæcum.	Bowel most discolored distant from cæcum.
5. Origin close to cæcum.	Origin probably more than two inches from cæcum.
6. Lateral dimple in ileum near its termination.	This not seen.
7. Discoloration of gut sharply defined.	Discoloration in gradation, and due to traction on the mesentery.

As will be seen, it may be quite impossible to decide to which class the intussusception really belongs, as they merge one into the other.

Evolution of an Invagination (Fig. 2).—The distinction between these two varieties may be an easy or may be a most vexed question. A very interesting complication may now be considered. If an intussusception begins two, three, or more inches above the ileum, the intussusceptum passes in part through the valve; but it is very variable as to how much, or all, of the invagination may pass through. The whole does sometimes pass through, and in doing so unrolls itself. The ring which marks the site of the invagination on the ileum may be gradually pulled down until it coincides with the margins of the ileocæcal valve. Inside the cæcum the enteric intussusception has consequently undone itself. This has come at least once under my observation, and a case reported for other reasons by Macfadyean in a horse, in the *Journal of Comparative Pathology*, April, 1903, shows a similar tendency. This is believed to be more common than may be supposed, and in itself, or its approximation, constitutes the greatest obstacle to

reduction by expression alone. And the enteric intussusception itself cannot be observed when the bowel is expelled from the cæcum.

FIG. 2.

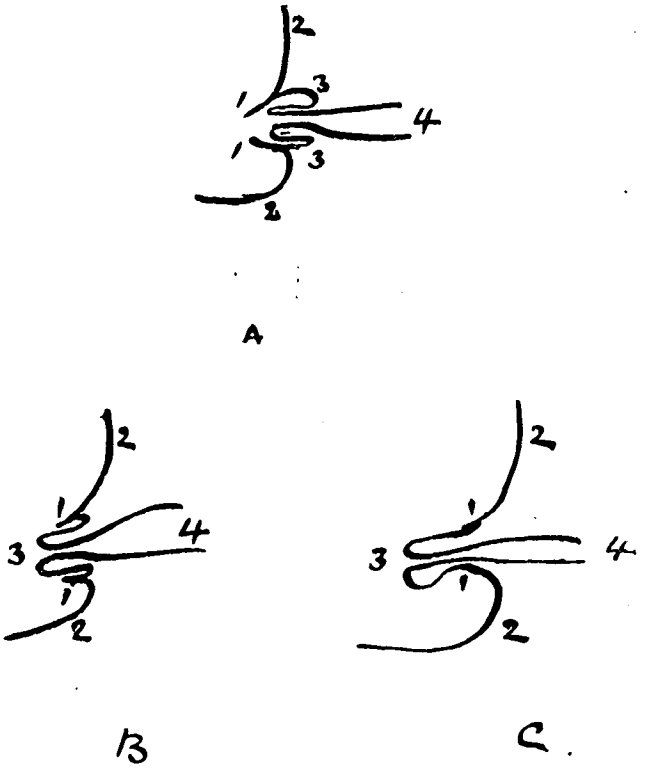


Diagram showing how an enteric intussusception may unroll itself at the ileocæcal valve in its different stages. *A* being the start of the invagination and *C* its final evolution. 1. The ileocæcal valve; 2. walls of cæcum; 3. the intussusception; 4. the ileum. In *C* the unrolling or evolution is complete.

In invaginations that begin in the last inch of the ileum, probably the most common site at which one originates, the phenomenon of unrolling or evolution is almost the normal state of affairs, and in itself is a great obstacle to reduction

expression alone. It may render the use of traction necessary for its final reduction.

It seems hardly necessary to mention, and so condemn, the diagnosis of the presence of the ileocæcal valve in the rectum by reason of the finger-tip. The apex of any intussusceptum will give a similar impression.

Pathological Remarks.—It is well known that intestinal obstruction occurring in the small intestine causes more acute symptoms than when the large is involved. But this statement certainly requires modification, because a number of purely enteric intussusceptions are more or less subacute or chronic; and it seems that the predominating factor is rather the completeness or incompleteness of the obstruction. Purely enteric intussusceptions are always short, and consequently the intussusceptum may be little œdematous, and the obstruction therefore incomplete. This has certainly been the case with two enteric intussusceptions that I have had the opportunity of examining after their excision. In both cases the lumen of the bowel was pervious to water. Again, as will be emphasized later on, the invagination may arise from the side of the bowel and not from a circular constriction. This will also aid in keeping the intestinal canal patent.

The most common place by far for intussusception to arise is in the last inch or so of the ileum; and it is here that the lateral dimple on the wall of the bowel can be most frequently seen after the reduction. Except in the case of polyps and the like, intussusceptions have been chiefly thought to arise in a circular contraction of the bowel aided by "irregular peristalsis," whatever that may mean. Nothnagel's classical experiments, quoted by Treves in his "Intestinal Obstruction," have done much to render this view fixed. But from the cases observed it seems that a lateral and not a circular origin is the most common.

It is a striking fact that the ileum is the situation in which invaginations are the most common, and more especially so in the last inch of it. It is difficult to see why the ileum should be more affected than the jejunum. The chief anatomical dif-

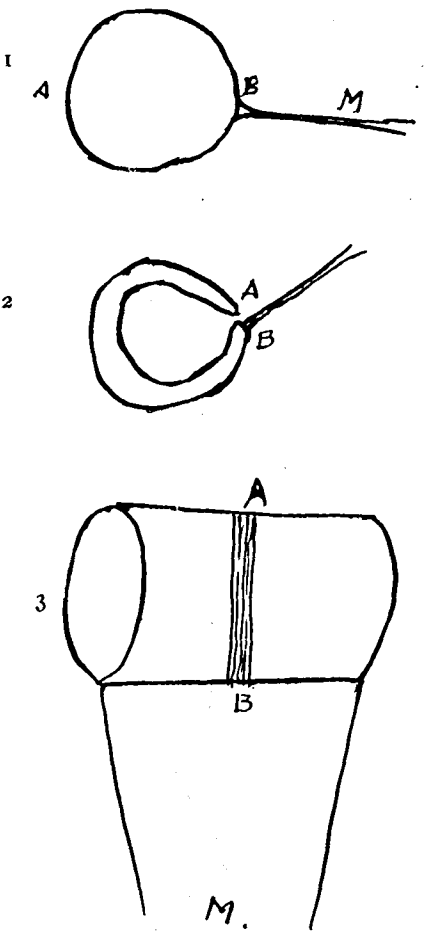
ferences being that in the former the walls are thinner and more pliable, and that lymphoid nodules and patches become more and more frequent as the ileocæcal valve is approached. Another point is the increasing viscosity of the intestinal contents. Also the ileum is becoming more fixed as it approaches the cæcum. Experience gained at operations undoubtedly represents that of experiments on man. Every surgeon must have opened the abdomen of a case or cases which have been diagnosed as obstruction, peritonitis, etc., and found that most interesting condition in which alternate segments of the bowels are contracted and dilated with no other lesion. Such a condition must be related to colic, and similarly there will be a relation between colic and intussusception. I have had such an experience more than once, and have tried pushing the contracted bowel into the dilated to see if I could produce anything like an intussusception. Nothing of the kind happened, and very probably due to the anæsthesia, as it is a matter of common observation that during operations it is not common to observe peristalsis. The production of an intussusception requires active and not passive intestines. One thing is certain with regard to the etiology of this subject, and that is, the association of intussusceptions with improper feeding is infinitely more common than the casual hospital note would lead one to believe. The mothers are naturally frightened, and do not tell the truth for fear of giving the notion that they are responsible in any way for their infants' distressful condition. But if inquiries are made carefully, it will be found that the onset of the pain began shortly after the child had eaten a piece of hard biscuit, or the like. The babies do not often show the condition of chronic gastro-enteritis and wasting, but are quite fat and healthy. Hence it appears that the intussusception is more dependent on the occasional indiscretion of diet than upon the customary. We know little or nothing of the pathology of colic or stomach ache, and it is probable that the above-mentioned clinical observation is of importance, and its association, *i.e.*, of the segments of collapsed and dilated bowel, with an undigested bolus may furnish the requisite physical conditions for

the production of an intussusception, the collapsed part being well pushed home into the dilated by the contraction excited by the undigested food. The invagination having been once started, it requires regular peristalsis to retain it; and if colic is "irregular peristalsis," it is just as likely to undo the intussusception as to keep it inverted. It seems reasonable to associate the formation of invaginations of the bowel with the "colicky" condition that has been found on the operating table. And as enteric intussusceptions are known to be short, and that every now and then cases are found which prove that intussusceptions may spontaneously reduce, it seems almost an act of philosophic faith to believe that enteric intussusceptions are of frequent occurrence, but that it is practically only when they involve the ileocæcal valve that they become urgent. In the last half-inch of the ileum the lateral wall of the gut becomes inverted and engages in the ileocæcal valve, which then contracts spasmodically upon it, and there is complete obstruction. A condition like this forcibly reminds one of prolapsed piles and the spasmodic contraction of the sphincter ani. A sacculus of the cæcum or colon inverted by the more solid fæces seems to be at the root of colic intussusceptions. The subject of primary ileocæcal intussusceptions will be left until the veterinary cases have been considered.

An interesting pathological point may be mentioned here, namely, how an intussusception travels to the anus, or even out of it. The greater part of the distance by far is accomplished by the stretching of the bowel wall, mesentery, etc. The presence of a second intussusception will also very likely help.

Before closing this section of the paper, I would like to refer to occasional bands that are found in these cases extending from the mesenteric attachment of the ileum, just above the cæcum, to its opposite border. I have been unable to form any sure idea on their origin and significance, but would suggest that they mark the site of a lateral invagination. The dimpling and the traction exerted by peristalsis will bring the two opposite borders in contact (2). The adhesion so formed will appear as a band when the bowel is reduced (3).

FIG. 3.



1. A loop of bowel with its mesentery, *M*. 2. The same loop laterally invaginated; the peristalsis pulls on the intussusceptum and approximates the borders of the gut, *A* and *B*. 3. Segment of ileum from an intussusception with the bowel reduced. The adhesion formed in 2 shows as a band, *A*, *B*.

Evidence of the Veterinary Record.—It is now our custom to turn to the lower animals for explanations of the problems of our own structure, functions, and pathology in the shape of experimentation, immunization, etc. But it has not been the custom to refer our morbid anatomy to them. As I applied a similar test to the influence of position in fractures and dislocations, in the *Lancet* of 1898, so has it been attempted to do the same with regard to the origin of intussusceptions. The results of my inquiry from a veterinary point of view have been published in the *Journal of Comparative Pathology* for 1903. In all, I found records of some forty cases, and in not a single one was the ileocæcal valve the originating point of the intussusception. It is most common in dogs, and, like man, begins in the small intestine, though apparently higher above the valve than in his case. Twenty-nine cases were described with sufficient anatomical detail to enable me with certainty to diagnose the varieties:

Nine cases were purely enteric.

Twelve cases were ileocolic.

Eight cases were colic.

Therefore, in twenty-one cases the invagination began in the small gut, and in eight in the large; in no case was the ileocæcal valve primarily concerned. The views founded on observations on mankind have been confirmed. With regard to the frequency of double intussusception in animals, it has not been always possible from the descriptions to decide. Four were certainly double, whilst as many as ten or twelve more may have been.

It is interesting to note that both clinically and experimentally (D'Arcy Power) cats seem immune or tolerant of intussusceptions.

The Ileocæcal Valve in Chronic and Acute Cases.—In conclusion, it may be pointed out that whilst in acute cases it seems probable that the inversion starts in the ileum and not at the ileocæcal valve, as then the obstruction is complete from the first. In chronic cases such as I have seen others, for example,

Mr. Makins and Mr. Battle, operate on, it does seem that the intussusception arises at the ileocæcal valve, probably by its being incompletely blocked.* As a result of the *vis a tergo* of the peristalsis of the small intestines, the valve is propelled into the cæcum, and slowly the inverted peritoneal surfaces contract adhesions or, as seems more probable, the inverted part becomes thickened and more or less irreducible. This state of affairs, the intestinal canal being patent, may go on for a long while, until finally a more acute exacerbation leads to its occlusion, and the case comes under observation.

It is interesting to consider the possible and perhaps probable position that intussusceptions of the ileocæcal type occupy. As primary invaginations, they are probably uncommon, especially so in acute cases. Among chronic intussusceptions they will be more frequent. As secondary intussusceptions they may be imposed upon an enteric, most commonly, or a colic which begins in the caput coli or the appendix. It may be found to exist more frequently in the secondary than in the primary form.

Invaginations in the lower end of the small intestine and in the large below, and about, the level of the ileocæcal valve are very likely to become double.

Treatment by Inflation, etc.—If the views that have been suggested here are right, they shed a very bright light upon the dangers and deceits of the treatment by inflation alone. In acute cases, beginning in the last half-inch of the ileum, it will probably be necessary to stretch the cæcum sufficiently to dilate the ileocæcal valve in order to release the ileum. And, unfortunately, the direction of the phlanges of the valve is such that the more the cæcum is distended the tighter is the valve closed. It also shows that, though the tumor may disappear through the reduction of the colic parts of the intussusception, the ileum may remain fixed in the jaws of the ileocæcal valve, and be quite

* It is, however, not clear that these invaginations have not originated in the caput coli.

undiagnosable without laparotomy. Operation, therefore, is the only intelligible method of treatment.

At the Hospital for Sick Children, Great Ormond Street, a practice has been made of beginning the reduction by inflation and finishing it by operation. In this way it has been found that the inflation reduces in suitable cases all but the invaginated small bowel, *i.e.*, the colic part, whilst it has left unreduced the enteric or, better, ileocolic. The difficulty in the reduction of this last part by inflation or expression is due to two reasons, firstly, the evolution of its invagination, and secondly, the spasm of the muscles of the valve.

Note on Museum Specimens.—When the stated frequency of ileocæcal intussusceptions is taken into account, one is very much struck by their comparative rarity among museum specimens. All the other varieties of intussusception are well represented. At the present day the opportunities of adding to the museum examples of invaginations of the gut are becoming fewer and fewer. And for knowledge of the anatomy it is necessary to rely more upon the surgeon than upon the pathologist. The natural result is that, with regard to the special subject under consideration, the museum series cannot in any way be regarded as representing the sum total of our knowledge. Moreover, criticism may be offered to the terms and descriptions there used.

Firstly, with regard to specimens labelled ileocæcal, only in a few cases have these been thoroughly examined, and, as a general rule, the diagnosis seemed to be based on superficial observation founded upon preconceived ideas. In many specimens the openings of the valve and the appendix are very clearly shown, and I would like to attract attention to the fact that in some cases the valve is in advance of the appendicular orifice, and sometimes *vice versa*. And it would appear that the latter cases have really started in the caput coli and not at the valve, being really colic, of a cæcal subvariety, and not ileocæcal.

Again, a further fact strikes the observer in that, in a very

large proportion (if not almost all) of these so-called ileocæcal cases, the valve is not closed, but open and patent in varying degree! It is apparently inconceivable that an open valve can be primarily responsible for the invagination unless blocked by some bolus of undigested food. It therefore seems probable that in most of these cases we must look for a further cause. And from observations at the time of operation I would suggest that it will be found in the last one-half to one inch of the ileum. Most museums have one or more specimens with the ileum still projecting through the valve. As was seen in many instances at the operation, many invaginations arose as a lateral dimple in the last inch or so of the ileum, and that this became engaged in the jaws of the valve, very much as a pile or prolapse may be grasped by the sphincter ani. The second colic intussusception will result from this blocking of the valve. But after death or excision the tonic contraction of the valve will relax, releasing the little invagination of the ileum, which may retreat or become smaller as the œdema fluid flows away, coagulation and contraction follows, etc. Hence there are reasons why this small gut protrusion may be absent in museum specimens.

One thing remains perfectly clear, and that is that by far the best and most satisfactory way to investigate the anatomy of an intussusception is to reduce one in the living subject or one just excised. Of course, formalin preparations would be satisfactory, but there is little opportunity. And in the absence of these, especially of the reduction, the *fons et origo mali* has never been observed, and the diagnosis must be received with caution.

It may be suggested that the hitherto called ileocæcal class will be resolved into those which start in the lower end of the ileum, in the cæcum, and a few that start at the valve itself. An invagination, therefore, commonly begins on one or other side of the ileocæcal valve, but rarely at it. Almost all museums neglect the existence of the more exact, if academic, division of intussusceptions into single, double, etc.

SUMMARY OF THE PRINCIPAL POINTS.

Reason has been found to suggest that

(1) Double intussusceptions are more common than single.

(2) Ileocolic-colic intussusceptions are the most common of all; enteric-ileocæcal or colic-ileocæcal next.

(3) The single ileocæcal variety is decidedly uncommon and found principally, or nearly entirely, in chronic cases.

(4) The ileocolic is the most common variety of primary intussusception.

(5) The inversion begins laterally and most frequently in the last part of the ileum, which becomes engaged in the jaws of the ileocæcal valve.

(6) The so-called ileocæcal forms probably arose in the last half-inch of the ileum or the caput coli.

(7) The evolution of the enteric invagination at the ileocæcal valve constitutes the chief difficulty in the reduction of the last part of the invagination, frequently rendering traction necessary.

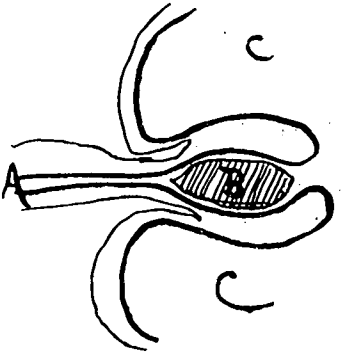
(8) That both in man and animals the ileocæcal valve is practically never primarily responsible for the trouble.

INTUSSUSCEPTIONS ASSOCIATED WITH INVERSION OF THE VERMIFORM APPENDIX.

By intussusception of the appendix is generally understood its inversion into the cæcum, which event is followed by the invagination of that structure into the ascending colon. Such an event is undoubtedly rare; but, as the majority of the cases have been recorded during the last few years, it may be safely prophesied that they are by no means so uncommon as has hitherto been supposed. A careful examination of the literature has led to the discovery of the reports of sixteen cases. In all of these the inversion was complete, and there was no scrap of evidence to show its pathogenesis. Fortune then led me to

a paper by Dr. Rolleston, of St. George's Hospital, London, in which he described a case of prolapse of the mucous membrane of the appendix into the cæcum. It was found at a post-mortem examination of the body of a woman aged thirty-two, who had died of peritonitis secondary to the perforation of a duodenal ulcer. The prolapse was obviously caused by the peristaltic action of the appendix excited by the presence of a concretion.

FIG. 4.



Heavy line, mucous membrane; fine line, peritoneum; *A*, appendix; *B*, fæcal concretion covered by mucous membrane projecting into the cæcum; *C*, cæcum.

The value and significance of this case have not been realized. It is the only adequately recorded case of partial inversion of the appendix into the cæcum, and so gives the key to the explanation of those cases of total inversion of the appendix associated with invagination of the caput coli. Up to this date, the subject had merely been one of speculation. Mr. D'Arcy Power, of London, has referred to a similar case in a discussion.

The small size of its lumen and the relatively great thickness of its walls preclude the invagination of the appendix into itself. Arguing from Rolleston's case, the invagination may be according to the presence of a concretion, a mass of secretion, a swollen lymphoid follicle, or the like, which is protruded

into the cæcum by the muscular action of the appendix behind it. The appendix forms the intussusceptum and the cæcum the intussuscipiens. This variety differs from all the others in that, owing to the large size of the cæcum (the intussuscipiens), it cannot contract closely enough to grasp and still further invaginate the appendix (or intussusceptum). The inversion is entirely due to *vis a tergo* on the part of the appendix, and *vis a fronte* is practically lacking. In such a way as this the appendix may be turned inside out. It is difficult to see how mere prolapse of the mucous membrane into the cæcum can progress farther, owing to the inability of the cæcum to grasp it and pull. Viewed in this light, Dr. Rolleston's paper is a most valuable contribution to the pathology of the cases under discussion.

The conditions produced by the inverted appendix into the cæcum may be likened to that produced by a long uvula in the pharynx. Both cæcum and pharynx are excited to swallowing movements, which, in the case of the former, cause the caput coli to be drawn up into the cæcum. If it is drawn up sufficiently far to obstruct the ileocæçal valve for an appreciable time, an attack of abdominal pain is experienced by the patient. But unless the caput coli is borne well above the valve, the cæcum seems unable to seize it and drag it onward, and the colic passes away, the valve becoming unblocked again owing to the recession of the caput coli and appendix. As these attacks succeed each other, the recession becomes less and less perfect, due to the chronic inflammatory changes and the formation of adhesions, until at last the ascending colon grasps the intussusceptum and superimposes an acute or subacute colic intussusception, aided by the *vis a tergo* of the small intestines. Clinically, these cases are very chronic, and at operation or post-mortem it is impossible to reduce the intussuscepted mass.

These cases are examples of double intussusceptions associated with the appendix. The primary invagination consists of the appendix followed by that of the caput coli. Later, a secondary colic form is superimposed on account of the primary

invagination blocking the ileocæcal valve.* Seventeen cases have been recorded, and every one of them was chronic, giving a history of a long period during which the patient was subject to colicky pains, vomiting, etc. Twelve occurred in males, four in females; all were chronic; sixteen occurred in children between the years of two and a half and nine; one occurred in a woman of forty-two. Eleven recovered, six died. In eight the gut was resected, of which six recovered; in five it was reduced, with four recoveries; in three the condition was found post-mortem.

It is extremely interesting to note that in no case had the inversion caused the appendix to slough. In this position the blood stream is not of necessity stopped, and it may not be seriously interfered with. And, again, the inverted position so alters things that the appendix no longer offers a culture tube like lumen for the nurture of organisms. Wallace, whose original paper I have been unable to consult, records a case of the passage of an appendix in a stool, but whether this was inverted or merely from an appendix abscess, cannot be said.

One further remark may be made. All, except one, of these cases occurred at an age before that at which appendicitis is common, and in no case was there a history of previous inflammations of that organ. In point of fact, appendicitis will very likely leave behind it such fibrosis, stricture, adhesions, etc., that it may be regarded as protective against inversion. The chronic catarrhal appendicitis that leads to the formation of concretions may be an exception to this.

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* It is not very clear whether this secondary invagination will be colic, as here stated, or ileocæcal. If the colon remains passive, the *vis a tergo* of the small intestines will push the valve onward, an ileocæcal invagination resulting. But if the colon actively contracts on the inverted caput coli, it will become invaginated itself, and the secondary invagination will be colic.

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INTUSSUSCEPTIONS ASSOCIATED WITH MECKEL'S DIVERTICULUM.

Intestinal invaginations associated with the persistence of the vitelline duct (Meckel's diverticulum) form rather an abstruse subject. But as triple and quadruple intussusceptions are found along with them, it has been thought that this paper might suitably follow in this connection. The nomenclature and classification of intussusceptions are essentially of pathological and academic interest, and the extreme rarity of the cases at present under consideration hardly gives the subject any practical bearing.

A short summary of the conclusions is given at the end of the paper.

Intussusceptions of Meckel's diverticulum are rare events and are of great interest. The all-important condition of Meckel's diverticulum in order for it to be invaginated is that it must be free from all adhesions. In the majority of the recorded instances of the presence of this diverticulum, it has been associated with some adhesions. Hence, it seems that by the results of its own pathological changes it becomes immune to invagination. Intussusceptions of the diverticulum may occur in a variety of ways, which may be broadly separated into those associated with patency at the umbilicus and those in which it is only connected with the ileum, its other end being free. The former class will be considered first.

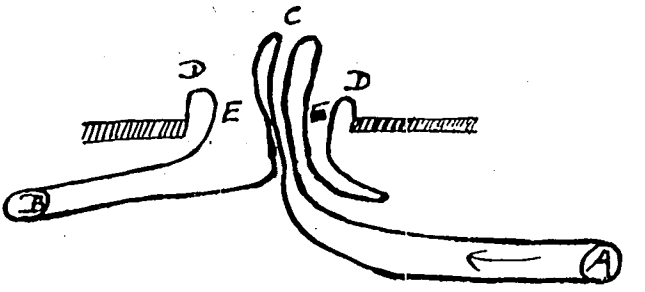
I.—Intussusceptions associated with a Meckel's diverticulum opening at the umbilicus.

(A) An invagination may form in the small bowel above the origin of the diverticulum, then descend and traverse its lumen so that the intussusceptum may become prolapsed at the umbilicus. This form of invagination is really a very complex one, being almost always associated with prolapse of the diverticulum itself, which surrounds the prolapsed intussusceptum like a collar (Figs. 5 and 6). The tumors formed in this way at the umbilicus are difficult to recognize. Fæces will only come from the apex of the central mass, the intussusceptum, and not from the groove around it. No fæces will be passed per rectum after one or two motions. This need not be a very rapidly fatal variety of intussusception; for as long as the lumen of the intussusceptum is patent the condition is really one of anus prenaturalis. The child wastes and dies if unrelieved. The pathological condition can be best understood by means of the following diagram.

Mr. Golding Bird, of London, has reported one of the most interesting of these cases in the Clinical Society's Transactions, 1896, xxix, p. 32. A male child, aged four weeks, was brought to Guy's Hospital with a fæcal fistula. On examination it was found to have a tumor at its umbilicus, from the summit of

which fæces were escaping. No fæcal matter was extruded from the groove round the base of the tumor. Ultimately the baby died.

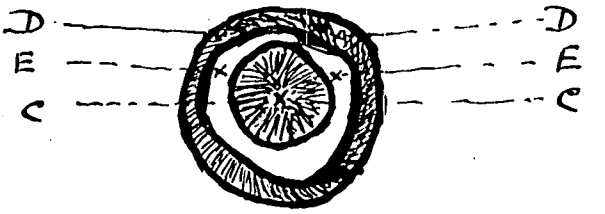
FIG. 5.



Diagrammatic section through the umbilicus. *A* is the small gut above the diverticulum, *B* is the small bowel below the diverticulum, *C* is the apex of the intussusceptum (the central mass), *D* is the prolapsed collar formed by the patent diverticulum, *E* is the groove between the intussusceptum and its collar.

(B) The next class of cases is where the posterior wall of the bowel opposite the communication between Meckel's diverticulum and the ileum becomes protruded through the umbilicus (Fig. 7, *X*). Such a condition may be brought about in two ways.

FIG. 6.

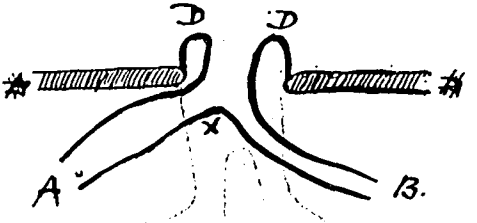


Bird's-eye view of umbilicus. Lettering as in Fig. 5. *C* is the intussusceptum, *D* is the collar of prolapsed diverticulum, and *E* is the intervening groove.

1. The process begins with prolapse of the patent Meckel's diverticulum through the umbilicus, starting with the part immediately next the navel. By these means the ileum is pulled

up to the umbilicus (Fig. 7), and its posterior wall, marked *X*, dragged on, so that it engaged in the bowel prolapsed at the

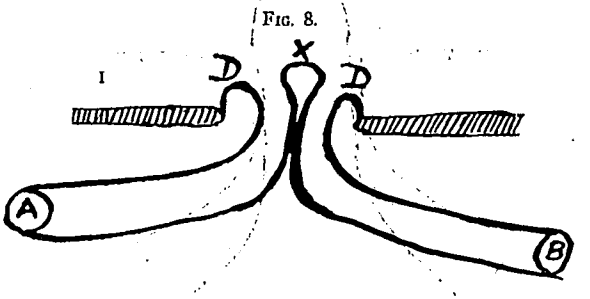
FIG. 7.



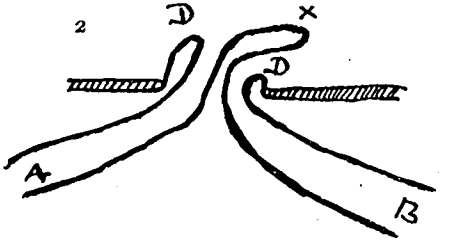
Prolapse of Meckel's diverticulum. Lettering as in Fig. 5. *A* is bowel above the diverticulum; *B*, that below; *D*, the prolapsed diverticulum.

umbilicus (Fig. 8). The invagination only occurs at the umbilicus after the whole of the diverticulum is prolapsed. It is therefore the result of the prolapse.

FIG. 8.



Intussusception of bowel through a prolapsed Meckel's diverticulum. Lettering as before.



Further development of Fig. 8, 1. Lettering the same, and note the similarity, Fig. 9, 4.

If the process continues, and more bowel is passed out the umbilicus, the intussusception is further increased. This is a unique variety, and differs from the greater degrees of prolapse of rectum in that the part marked *X* is the intussusceptum, and

FIG. 9.

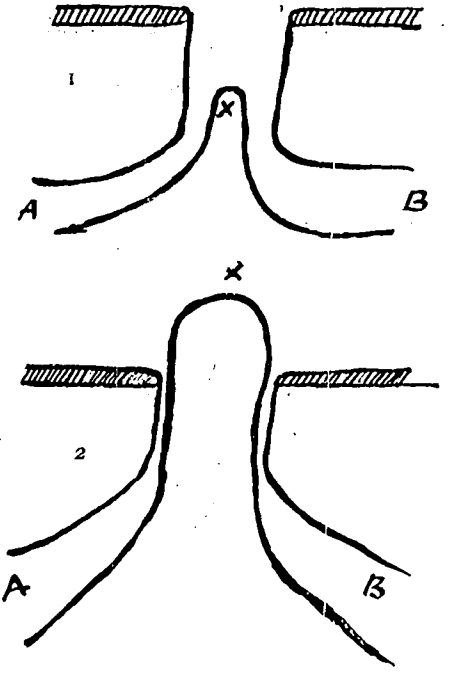
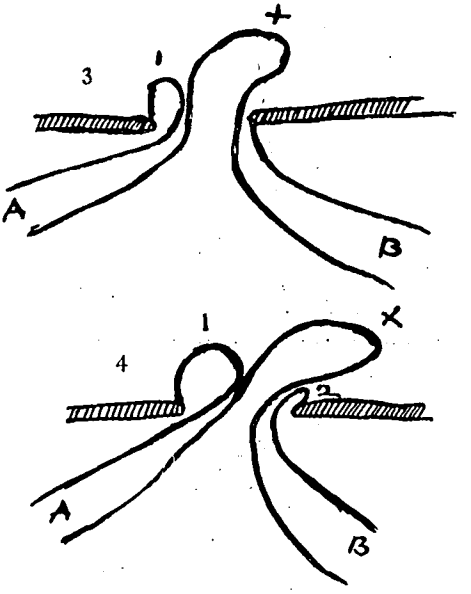


Diagram illustrating the intussusception of the posterior wall of the ileum at the place where the diverticulum joins it (1, *X*). In 2 the intussusceptum is passed out of the umbilicus. *A* is the bowel above, and *B* that below, the junction of the diverticulum; *X* marks the prolapsed intussusceptum.

the already prolapsed walls, *D*, represent the intussuscipiens. In prolapse of rectum there is no intussuscipiens, and therefore there can be no intussusception in the true and logical meaning of the word. The intussusceptum in this case differs from that of the ordinary intussusception in that it is derived from one

side of a strip of bowel and not from a circular or oval infolding.

2. In this division, the posterior wall of the ileum opposite the internal opening of Meckel's diverticulum, owing to some bend or kink, gets caught by the diverticulum, whose peristalsis passes it out at the umbilicus.



Further stages of Fig. 9. In 3 the part of the walls of the diverticulum next to the bowel above has been prolapsed, 1. This is soon followed by that of the opposite wall of the diverticulum, 4, 2. Note the asymmetry of the collar surrounding the intussusceptum, *X*.

In these cases the diverticulum need not be prolapsed at all. A tumor projects from the umbilicus having no aperture on its apex, and fæces come from the groove around it. Nothing will be passed per anum. This protrusion, if the child lives, tends to become polypoid, and has been ligatured and cut away. It represents the spur, or éperon, in a colostomy, and may be treated similarly. There is considerable importance in recog-

nizing this class of case. Owing to the fact that little or none of the diverticulum is prolapsed, there is little or no collar round the central tumor.

(C) One of what I believe to be a common way in which the diverticulum becomes invaginated is that the intussusception starts in the diverticulum itself, and practically always at the

FIG. 10.

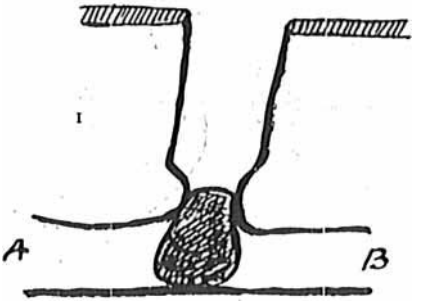
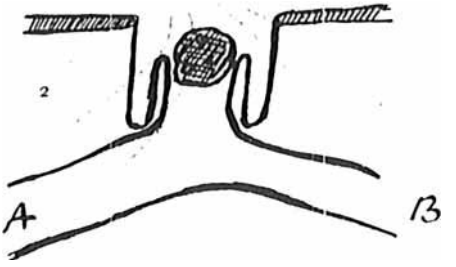


Diagram of intussusception beginning at the junction of the diverticulum and the ileum. Lettering as before.

1. Formation of invagination with suggested bolus of undigested food.



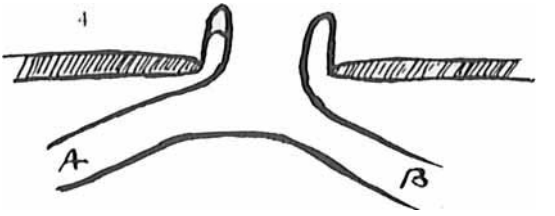
2. Invagination formed.

point where it joins the ileum. The start of the invagination is some undigested or improperly digested bolus, which is seized by the internal opening of the diverticulum, and at the same time thrust onward by the contraction of the ileum.

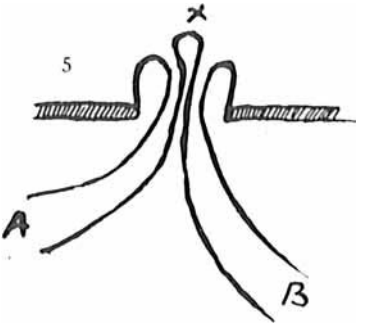
The invagination is formed at the most internal part of the diverticulum and pushed by the contraction of the ileum into the

tube (Fig. 10, 1 and 2). The intussusception thus formed is extruded at the umbilicus, and in so doing undoes the invagination (Fig. 10, 3 and 4). Then the ileum itself may be protruded from the navel (Fig. 10, 5).

3. Invagination passing through the umbilicus.



4. The invagination has in passing through the umbilicus become everted, and is simply a prolapse of the diverticulum.



5. The posterior part of the ileum is invaginated and extruded from the umbilicus. Note asymmetry of collar. See Fig. 8, 2, and Fig. 9, 4.

The clinical appearance in the final stages of this last class is similar to that which was just described as resulting from primary prolapse of the diverticulum (Figs. 7 and 8). In it,

as a rule, the intestinal obstruction is most complete, and clinically the pathological process may stop at any of the stages, particularly (Fig. 9, parts 2 and 3) if the case becomes acute. If the stage of Fig. 9, parts 4 and 5, is reached, the obstruction is relieved and the case becomes more chronic.

It is a matter of considerable probability that some of the cases reported as prolapse of Meckel's diverticulum are not really cases of intussusception without acute obstruction. (Such as Löwenstein, Langenbeck's *Archiv für klinische Chirurgie*, 1895, xlix, 541–563.)

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FIG. 11.

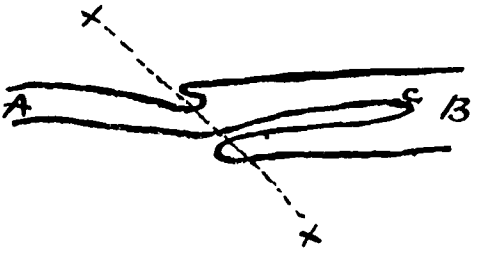
Inverted diverticulum. *A* is the bowel above, and *B* that below, the inverted diverticulum *C*. In the diagram the structures are represented uncollapsed.

II.—Intussusceptions of a Meckel's diverticulum which is only attached to the bowel.

This is the more common developmental defect than that of the patent fistulous tract at the umbilicus. The diverticulum is found in more than 2 per cent. of bodies. Most commonly it is a hollow process, two or three inches long, attached to the free border of the ileum about thirty inches above the ileocæcal valve. Its situation on the ileum is, however, subject to many variations. The invagination practically always begins at the free tip of the process, which becomes completely inverted into the ileum. This is not so frequent as might have been expected, probably because the majority of cases in which the presence of the diverticulum is recorded it has been adherent.

The inverted diverticulum irritates the surrounding bowel, which by peristalsis pushes and pulls it onward, so dragging in the bowel wall to which it is attached. But, as the origin of the invagination is lateral, the ring where the bowel is infolded is very oblique, and consequently the intestinal lumen is not completely occluded, and the case may be clinically subacute (Fig. 12).

FIG. 12.



Showing the invagination that begins unilaterally, and *X*, *X*, shows the obliquity of the ring where the bowel is infolded. *A*, *B*, and *C*, as in Fig. 11.

This is a very interesting pathological fact, and explains why some of the recorded cases give long subacute histories, and in which an adherent inverted process is found at the bottom of a recent acute invagination. It is impossible to say how many of the reported cases come under this explanation, as the pathological descriptions do not always allow of an opinion being formed.

In other cases the intussusception is acute, and I believe is brought about in the following way. The inverted process is grasped by the ileum in a way similar to the contraction which is known to occur on a gall-stone, and the obstruction is complete.

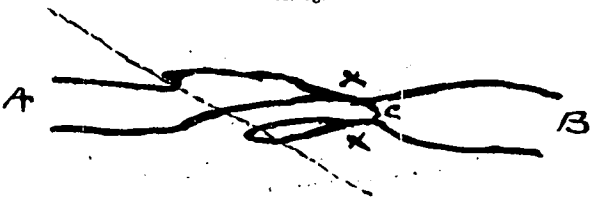
The result of this block is that the whole is pushed on into the small bowel below, and a secondary enteric invagination is added.

This may travel as far as the ileocæcal valve, which it may then either go through wholly or in part, or it may push the valve in front of it. The first is called an ileocolic intussuscep-

tion, and the second ileocæcal. Travers admirably describes an ileocolic case.

When the various invaginations are considered anatomically, they are found to be very complex. To begin with, there is the intussusception and inversion of the diverticulum itself.

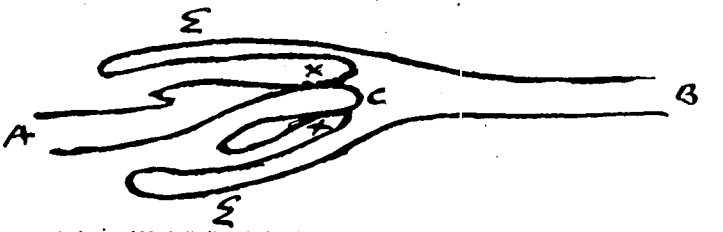
FIG. 13.



Illustrating the inversion of the diverticulum (*C* at its tip), which is grasped by contraction of the small bowel at *X*, *X*. Dotted line indicates the obliquity of the ring of the infolding of the bowel. For clearness, the inverted process is not represented as compressed. *A* and *B* as before.

In acute cases this is grasped by the small bowel, and second invagination of the enteric form is added by the propulsive power of the small intestines. In chronic cases by bowel is secondarily invaginated by the traction of peristalsis on the

FIG. 14.



An inverted Meckel's diverticulum intussuscepted into the ileum. *A* and *B* as before, *C* at the tip of the inverted process, *X*, *X*, at the points where this is grasped by the ileum, and *E*, *E*, are the layers of the secondary intussusception.

inverted process. Thus clinically and pathologically these two types may be seen. In some cases these two enteric invaginations may be present together, when that formed by traction behind the inverted process is small. Thus it is seen that two types exist.

1. A double intussusception of chronic cases, *i.e.*, traction.

2. A double intussusception of acute cases, *i.e.*, propulsion.

3. A triple intussusception of cases, especially where an acute attack is imposed on a chronic, and both traction and propulsion enteric intussusceptions may be present together.

When this compound intussusception reaches the ileocæcal valve, one and two may remain double intussusceptions, the enteric part becoming ileocolic, *i.e.*, passing through the valve. Or they may push the valve forward and become triple by the addition of an ileocæcal intussusception. In the third case similar changes may occur to that just described. That is, it may remain triple by part becoming ileocolic, or it may become quadruple by the addition of an ileocæcal invagination.

For the nomenclature of these cases, the following may be suggested.

x 1. Diverticulum-enteric (chronic).

x 2. Enteric-diverticulum (acute).

* 3. Enteric-diverticulum-enteric. (Typically acute or chronic.)

At the ileocæcal valve.

x 1. Diverticulum-ileocolic.

x 2. Ileocolic-diverticulum.

* 3. Ileocolic-diverticulum-enteric.

Or,

* 1. Diverticulum-enteric-ileocæcal.

* 2. Enteric-diverticulum-ileocæcal.

‡ 3. Enteric-diverticulum-enteric-ileocæcal.

As in all ileocolic forms, the valve may become impacted and a further colic variety of invagination formed. Thus the above may become

* 1. Diverticulum-ileocolic-colic.

* 2. Ileocolic-diverticulum-colic.

‡ 3. Ileocolic-diverticulum-enteric-colic.

Those marked x are double intussusceptions, those * are triple, and those ‡ are quadruple. Intussusceptions associated

with an inverted diverticulum constitute the most common forms of triple and quadruple intussusceptions.

Sixteen cases of this second great class of intussusception associated with the inversion of a Meckel's diverticulum have been recorded. Most of them were fatal and most of them were acute. Two most successful and more chronic cases are recorded by Travers and Zum Busch. Some, usually the chronic, occurred in adults; but this second class is found in older subjects than those with the diverticulum patent at the navel.

SUMMARY.

Intussusceptions associated with Meckel's diverticulum fall into two groups.

I. When the process opens at the umbilicus as well as into the small intestine.

II. When it is only in connection with the intestine. This is the larger group.

I. The first group may be subdivided as follows:

(A) An enteric intussusception formed above the process, traverses it, and is extruded at the umbilicus. Figs. 5 and 6.

(B) The ileum opposite the internal opening of the diverticulum becomes protruded at the umbilicus.

α. As a result of prolapses of the diverticulum. Figs. 7 and 8.

β. Primary extrusion of this part of the ileum. Fig. 9.

(C) The intussusception begins in the diverticulum itself. Fig. 10.

II. The inversion of the diverticulum in *acute* cases is associated with an enteric intussusception, the gut grasping the process is forced onward, propulsion. Figs. 13 and 14.

In *chronic,* the inverted process inverts the ileum behind it by dragging, traction. Fig. 12.

In acute attacks on a chronic, both these traction and propulsion enteric invaginations may be present. Fig. 14.

The most common triple and quadruple intussusceptions are associated with the inversion of this process.

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